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The relationship between the nine General Aptitude Test Battery (GATB) aptitudes as well as the GATB composite and success in a vocational-technical curriculum as measured by shop grades is investigated. Two different samples were used and both consisted of 10th grade boys enrolled in Shop Courses in the Altoona, Pennsylvania Area Vocational Technical School. Data was analyzed by computing zero order correlations and then submitting these to multiple regression analysis using the technique of elimination of variables by parsimony. The following results were found: (1) correlations were high enough to warrant development of aptitude patterns for individual shops, (2) certain aptitudes over a short period of training appear to be fairly stable, (3) variability exists from one sample to another and from one occasion to another in the degree of relationship between aptitudes and training success, (4) certain aptitudes are more improtant than others for success in vocational training, and (5) raw score grades may be as useful as converted grades as a criterion of training success. An implication from this study suggests grouping according to common aptitudes required as determined through empirical evidence rather than grouping shops together. (Author/EK)

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EXPLORING THE USE OF THE GATB WITH NINTH GRADE BOYS

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Due to recent federal legislation and increased societal demands, there has been a tremendous increase in vocational-technical education opportunities available to our students today. In order to provide students with some of the information they need to make a curriculum choice from among the additional number of alternatives in a particular school, the counselor may find it helpful to select certain tests and inventories. For the purpose of generating information related to student abilities, many counselors are looking towards the General Aptitude Test Battery (GATB) because of its many years of successful use by the United States Employment Service (USES).

The GATB was first released by the USES in 1947 for use in employment counseling (primarily with adults). The first edition of the GATB (B-1001) contained 15 sub-tests and was designed to measure 10 aptitudes. As an outgrowth of research findings based on the first edition, an improved version (B-1002) was released in 1952 which contained 12 sub-tests and was designed to measure 9 aptitudes. The revised edition is made up of 8 paper-and-pencil sub-tests and 4 apparatus sub-tests. The entire battery takes about two and one quarter hours to administer and consists of the following aptitudes:

G-Intelligence--General learning ability; V-Verbal Aptitude; N-Numerical Aptitude; S-Spatial Aptitude; P-Form Perception; Q-Clerical Perception; K-Motor Coordination; F-Finger Dexterity; M-Manual Dexterity.

Raw scores from the tests are converted to standard scores which have a mean of 100 and a standard deviation of 20 based on adult norms. In 1959 norms were first released for ninth and tenth grade. On the basis of data collected since that time and on maturation studies by Droege (1966) new normative information for ninth and tenth grade was released in 1966-1967.

Occupations which require similar aptitudes have been grouped together to form Occupational Aptitude Patterns (OAP's). Each OAP consists of three of the nine aptitudes found to be significant for that family of occupations. OAP's are reported in terms of cut-off scores, but Droege (1966) points out that for ninth and tenth grade, cutting score bands equal to plus or minus one standard error of measurement should be used. Interpretation on OAP's should be restricted to those scores which fall outside the bands when using them with ninth and tenth graders.

Review of Literature

A brief review of the literature will help to highlight some of the work which has been done with the GATB in respect to high school level vocational-technical programs. Culhane (1964) describes the release of the GATB for use in the schools and makes suggestion for its application. Before that time to the best of my knowledge only one study had been done in the schools which is reported in the literature. Samuelson (1956) reported multiple correlations from .508 to .827 between a composite of three GATB aptitudes and instructors' ratings of 136 male vocational students over 16 years of age enrolled in 6 shop areas. Since 1959 Droege has conducted extensive research with ninth and tenth grade students. Much of his results can be obtained by reading Chapter 19 and 20 of the GATB manual "Section III" on development. In a number of published articles Droege (1965) reported a multiple correlation of .38 between a composite of four GATB aptitudes and instructors' ratings of 70 ninth grade boys enrolled in a printing course. Droege (1966) reported on a study of the effects of maturation on GATB scores and found increased stability with each year from ninth to twelfth grade. Droege (1968) found small differences in intercorrelations of GATB aptitudes from ninth to twelfth grade.

Ninth grade intercorrelations were generally higher where differences did occur, especially for Manual Dexterity (M). The largest standard deviations (greater variability) were for the aptitudes S, K, F and M. Girls differed from boys in many respects.

Ingersoll and Peters (1966) reported a multiple correlation of .621 between a composite of Form Perception (P) and Verbal Aptitude (V) of the GATB and the grade point average of ninth and tenth grade mechanical drawing students.

Ghiselli (1966) in his book The Validity of Occupational Aptitude Tests synthesizes information about aptitude tests in general. Prediger, Waple and Nusboum (1968) summarized research pertaining to prediction of success in high school level vocational programs. Their major findings parallel some of Ghiselli's earlier work. In general, they found variation in results from study to study, differences for males and females, evidence of differential predictability and low predictor value for dexterity tests.

Purpose of the Study

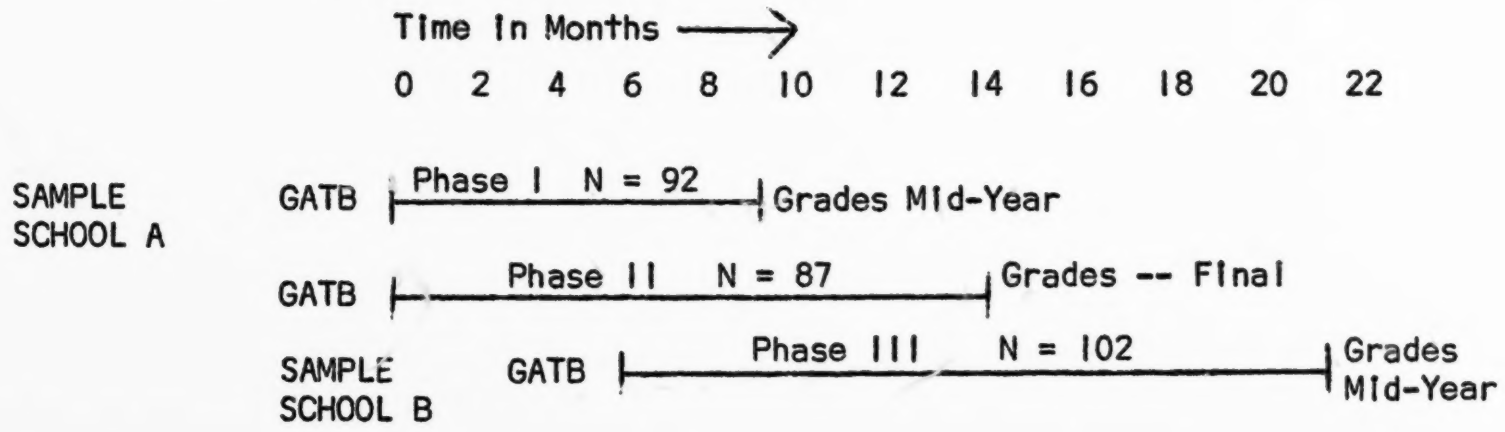
The major purpose of this investigation is the study of the relationship between the nine GATB aptitudes as well as the GATB composite and success in a vocational-technical curriculum as measured by shop grades. Specifically, the study sought to uncover evidence pertaining to the use of the GATB in a particular school system. It is hoped that an investigation of this nature will provide a framework for school systems with vocational-technical programs that wish to provide useful aptitude information to ninth-grade students for career decision making purposes. Answers to the following questions are important to a school system considering using the GATB for vocational counseling.

1. What magnitude of relationship between the aptitudes and shop achievement can be expected?
2. What is the stability of the relationship over a period of training time?
3. What is the stability of the relationship over the same amount of training time from one year to another and one sample to another?
4. What aptitudes can be expected to yield the most useful information over all shops? (What is the contribution of the manipulative aptitudes K, F and M?)
5. What is a suitable criterion of shop achievement for the purpose of studies of this nature?

Procedure

Two different samples were used in the study and both consisted of tenth-grade boys enrolled in shop courses in the Altoona (Pennsylvania) Area Vocational Technical School. Phase I of the study involved a correlation and regression analysis, and was conducted with 92 tenth grade boys who had completed approximately five months of instruction. GATB data was gathered during the previous year (nine months earlier) when the students were attending junior high school A. Achievement criterion was mid-year shop grades. Phase II involved a similar correlation and regression analysis utilizing the identical GATB data for those same phase I students (sample size reduced to 87 due to withdrawals), but with the achievement criterion being end of year grades (approximately 14 months from GATB testing). Phase III consisted of a similar statistical analysis, but with 102 tenth grade boys who had also completed approximately five months of instruction. GATB data on this independent sample also was gathered during the previous year (approximately 15 months earlier) when the students were attending junior high school B. Achievement criteria again consisted of mid-year grades gathered exactly one year from phase I mid-year grades.

Diagram of Samples and Data Collection Over Time



The criterion of success was shop grades assigned by the instructor. Grades were assigned on a five-point scale with five being equal to A, one equal to F. Phase I and II consisted of grades from 14 shops and Phase III included 16 shops (being a year later two shops had been added). Because of the small sample size in each shop, it was necessary to group several shops together in order to carry out a meaningful analysis. In order to eliminate differences among teachers' grading systems within a grouping of several shops, standard scores with a mean of 500 and a standard deviation of 100 were used. The following rationalewas used as a basis for converting the raw grades to standard scores.

The necessary characteristic of achievement measured by grades is that a particular grade such as "c" obtained by one member of the sample is equivalent to a "c" obtained by another member of the sample. In grouping raw scores together, this characteristic would be lost. (The "c" obtained by a student in shop x might have been the lowest grade given by the instructor in shop x, whereas the "c" obtained by a student in shop y might have been at the median of the distribution of grades given by the instructor in shop y.) In converting to a standard score distribution, information about the actual grade received by a student was given up so that equivalency of the achievement measure could be obtained.

As was stated earlier, because of small sample size within each shop, grouping of several shops together was used for the analysis. To the exent that a grouping contained a greater number of shops, differential prediction information would be lost, but this was necessary to achieve sufficient sample size. During Phase I and II there were 14 shop areas involved. Three groupings were decided upon based on technological involvement. Level I--Computer Technology and Drafting and Design Technology; Level II--Auto Mechanics, Electricity, Machine and Printing; Level III--Auto Body, Carpentry, Home Appliance Repair, Planing Mill, Plumbing, Sheetmetal, Trowel Trades and Welding. For Phase III there were 16 shop areas. Engineering Related Technology was added to Level I and Building Maintenance was added to Level III. Table I describes the two samples by level based on percentile equivalents of mean scores for each GATB aptitude. Table II shows the differences between these two samples based on standard deviation.

The data was analyzed by computing zero order correlation and then submitting these correlations to multiple regression analysis using the technique of elimination of variables by parsimony. This method compares the amount of predictable variance using a composite of all predictors with a composite of all predictors less one (the least contributing predictor). This procedure is continued until only one predictor remains. The corresponding loss in predictor variance with each elimination can be observed and the most significant predictors can be identified. For the purpose of this study the last three significant predictors were used to make comparisons. Table III shows the results of this analysis.

Results

Results of this investigation are reported in terms of the research questions posed previously. They are presented sequentially in the following discussion.

Question 1 -- What magnitude of relationship between the aptitudes and shop achievement can be expected? Table III contains the results of the regression analysis for all three phases of the study for each of the four groupings (Level I, II, III and Total). Multiple R's are reported using all nine GATB aptitudes and for the last three aptitudes remaining in the regression elimination. The last aptitude remaining in the analysis is a zero order correlation. Using all nine aptitudes the Multiple R's range from .77 to .29 with a median R = .535. The last three aptitudes remaining were selected arbitrarily as significant aptitudes because it is approximately at this point where a substantial loss in the Multiple R's occurred. The range of Multiple R's with three aptitudes remaining is from .65 to .25 with a median R = .445. For the zero-order correlations the range is from .59 to .17 with a median r = .345. While these correlations are not exceedingly high, it must be remembered that a number of shops have been grouped together. This procedure has the tendency to reduce the magnitude of correlations obtained. This effect can be observed by comparing the levels which contain fewer shops with the total which contains all of the shops.

Question 2 -- What is the stability of the relationship over a period of training time? Table III shows the relationship over time when School A mid-year grades are compared to School A year-end grades. Comparing the three most significant aptitudes for each of the four groupings (12 in all) from mid-year to end of year it can be seen that seven of the twelve aptitudes

remained as the last three significant predictors. The most significant single predictor was the same at each of the three levels, but was different for the total group. While the significant predictor aptitudes remain fairly stable over time, it can be seen that the size of the correlation had a tendency to shrink as would be expected. Correlation between mid-year and end of year grades for the total sample was found to be .71.

Question 3 -- What is the stability of the relationship over the same amount of training time from one year to another and one sample to another? From tables I and II the differences between the two samples in terms of percentile equivalents of mean GATB scores and standard deviations for each aptitude may be seen. It may also be observed from table I that sample B has percentile scores which for most of the individual aptitudes are lower than those for sample A. This is true for each level and for the totals. Although the mean score of the samples differ the variability of each sample does not differ greatly as is indicated by table II. From the data we can conclude that even within a given school system there may be a difference in aptitudes from one school to another although the amount of a variability remains the same. This may or may not affect prediction. From table III it is possible to compare school A mid-year grades with school B mid-year grades. Only four of the twelve aptitudes in sample A remained as the last three significant predictors in sample B. Also it can be seen that the magnitude of correlations in sample B is much smaller than in sample A. This could be due to two factors: (1) Fifteen months had elasped since the time of GATB testing as opposed to nine months in sample A; (2) Lower scores overall in sample B result in smaller correlations even though variability remains approximately the same. In either case there is definitely a great deal of difference from

one sample (and year) to another. This agrees with what Ghiselli and Prediger had found previously.

Question 4 -- What aptitudes can be expected to yield the most useful information over all shops? (What is the contribution of the manipulative aptitudes, K, F and M?) By using a simple count of the aptitudes which appear most frequently as significant predictions some insight into important aptitudes may be gained. From table III looking at all 36 significant predictor aptitudes in the three phases of the study it can be seen that the aptitudes F, V and P appear only once. The aptitude which appears most often is K followed by N, G and M. A number of trends are interesting to note although no conclusion can be drawn. It appears that the manipulation aptitudes K and M are significant predictors for the samples studied. Aptitude F appears to be of little importance. This finding agrees, at least in part, with previous research. Also it can be seen from table IV that when the levels are combined, correlations with K, F and M are near zero while this is not the case at each level. This may be interpreted as evidence of importance of manipulative aptitudes in certain shops only.

Question 5 -- What is a suitable criterion of shop achievement for the purpose of studies of this nature? All three phases of this study were carried out using grades converted to standard scores. As was explained earlier, this was deemed desirable in order to combine shops together. Table IV shows a comparison between the converted standard scores and the raw scores for zero-order correlations with the nine GATB aptitudes for the school B sample. While raw scores and converted scores correlate highly (as should be expected) there are some differences in their correlations with the GATB aptitudes. Overall, it appears that the raw score grades bear a slightly

greater relationship to the GATB aptitudes than do the converted grades. Table V, however, shows that regardless of which grades were used, the results in terms of the last three significant aptitudes is practically the same. While there is some switching of position, ten of the twelve aptitudes are the same for both methods. A possible explanation of the similarity in correlations between the GATB aptitudes and the two types of criteria (standard scores and raw scores) is that some instruction in their grading systems has already accounted for differences among shops in terms of the aptitudes of the students in their shop. (For example, in a shop with higher ability students, the instructor gave only A's, B's, and C's. In a shop with lower ability students, the instructor gave only C's, D's, and F's.) A check of the raw score grades by shop showed this to be the case in some shops.

Summary and Conclusions

Based on an analysis of the data in light of the questions asked the following conclusions were reached.

1. The multiple correlations involving several significant aptitudes are sufficiently high to warrant development of aptitude patterns for individual shops or possibly for a grouping of highly related shop areas.
2. The importance of certain aptitudes over a short period of training time appears to be fairly stable although the degree of their relationship to success is more difficult to access as time and training progress.
3. There is evidence of a considerable amount of variability from one sample to another and from one occasion to another in the degree of relationship observable through correlational studies

between aptitudes and training success. This agrees with Ghiselli, and is explained in his text (see Ghiselli, p. 30). However, even though this variability exists it is still possible to identify significant aptitudes. The fact that it is not unusual to find such differences among what appears to be similar situations suggests that caution should be used in generalizing results from one local program to another and from one school system to another.

4. Certain aptitudes do appear to be more important than others for success in vocational-technical training. Contrary to Ghiselli and others the manipulative aptitudes do have predictive value especially in specific shop areas. However, when many shops are combined the value of the manipulative aptitudes for prediction has a tendency to diminish rapidly.
5. Depending on the grading system used in a school system and on the homogeneity of grading practices, raw score grades may be as useful as converted grades as a criterion of training success. However, because of certain advantages of standard score grades, this author would suggest their continued use in studies of this nature and would extend their use in the schools.

Some additional implication from this study can be observed. Taking all the results as a whole, it appears that grouping of shops together as was done for this study seriously hinders the usefulness of the results for application in a specific school. Because the GATB does appear to be measuring different abilities and because different kinds of work require different abilities, the grouping together of different shops has the effect of canceling out a high degree of relationship for any one shop with one or several

aptitudes. Instead of levels of technological involvement as was used here the author suggests grouping according to common aptitudes required as is determined through empirical evidence. The study by Doerr and Ferguson (1968) The Selection of Vocational-Technical Students provides an example of this kind of procedure and would serve as a good guideline to school systems interested in developing their own aptitude patterns. Ghiselli (1966) and Prediger et al., (1968) should also be consulted for suggestion in developing useful aptitude information.

Some of us in the Department of Vocational Education at Penn State believe that the GATB shows promise for counseling use with youngsters contemplating vocational-technical training. For this reason we are presently undertaking a project of a longitudinal nature involving a much larger sample to explore further some of the ideas stimulated by this study.

TABLE I

Percentile Equivalents of Mean GATB Scores Based on 9th-Grade Norms*
For Schools A and B at all Three Levels and Total Sample

Level		G	V	Aptitudes N	S	P	Q	K	F	M
	I									
A	N = 22	68	50	74	71	80	64	71	62	71
B	N = 29	57	48	60	62	69	69	42	47	55
	II									
A	N = 35	46	42	53	49	55	48	50	41	50
B	N = 36	38	35	34	57	48	55	40	52	35
	III									
A	N = 35	46	41	54	48	52	50	47	41	46
B	N = 37	34	33	39	38	42	52	30	48	30
	Total									
A	N = 92	50	44	58	54	60	53	54	46	53
B	N = 102	42	38	44	51	53	59	37	50	37

*Percentile equivalents are approximations based on Table III of the Manual for the General Aptitude Test Battery, Section II: Norms.

TABLE II

STANDARD DEVIATIONS FOR EACH APTITUDE IN RANK ORDER
FOR TOTAL SAMPLES IN SCHOOLS A AND B*

	Aptitudes								
	Standard Deviations								
School A	M	F	P	K	S	N	G	V	Q
N = 92	17.8	15.9	15.4	13.8	13.6	13.5	11.3	9.7	8.1
School B	P	S	F	M	K	N	G	Q	V
N = 102	18.2	17.5	17.1	16.4	13.6	13.2	12.0	10.3	9.4

*Expected Standard Deviation for Adult Population is 20.

TABLE III

MULTIPLE CORRELATIONS USING ALL 9 APTITUDES AND LAST 3 APTITUDES REMAINING IN REGRESSION BETWEEN SCHOOL A MID-TERM AND FINAL GRADES--SCHOOL B MID-TERM GRADES ONE YEAR LATER USING GRADE CONVERTED TO STANDARD SCORES

	School A--Mid-Year Grades				School A--Year-End Grades				School B--Mid-Year Grades			
	Multiple R with all 9 Aptitudes	Multiple R with last 3 significant aptitudes			Multiple R with all 9 Aptitudes	Multiple R with last 3 significant aptitudes			Multiple R with all 9 Aptitudes	Multiple R with last 3 significant aptitudes		
	9 3	2		1*	9 3	2		1*	9 3	2		1*
Level I	.69	.65 N	.61 S	.59 K	.52	.34 N	.32 M	.18 K	.77	.64 K	.58 Q	.48 S
Level II	.64	.58 F	.54 K	.42 G	.64	.56 M	.50 K	.39 G	.44	.27 N	.20 G	.17 S
Level III	.55	.50 S	.45 M	.35 N	.56	.48 M	.46 K	.37 N	.48	.41 G	.39 K	.34 P
Total	.33	.32 K	.31 G	.25 M	.29	.27 V	.26 M	.23 N	.30	.25 G	.23 N	.18 S

*Last significant aptitude = Zero-order correlation

TABLE IV

COMPARISON BETWEEN STANDARD SCORE AND RAW SCORE GRADES ON ZERO ORDER CORRELATIONS WITH THE 9 GATB APTITUDES FOR THE SCHOOL B SAMPLE

	Correlations Between Standards Scores And Raw Scores	Aptitudes G	V	N	S	P	Q	K	F	M
Level I	.92	.40	.12	.28	.48	.12	.32	-.27	.02	.19
Standard Score		.46	.08	.28	.49	.03	.27	-.40	-.01	.13
Raw Score										
N = 29										
Level II	.94	.01	-.02	.07	.17	-.16	-.09	-.14	.02	-.11
Standard Score		.01	-.04	.10	.10	-.10	-.06	-.15	-.12	-.16
Raw Score										
N = 36										
Level III	.94	.13	-.04	.21	-.04	.34	.27	.28	.14	.17
Standard Score		.08	-.12	.20	-.07	.38	.38	.44	.10	.22
Raw Score										
N = 37										
Total	.86	.13	.01	.16	.18	.08	.16	-.05	.05	.06
Standard Score		.27	.09	.29	.23	.19	.29	.02	-.03	.10
Raw Score										
N = 102										

TABLE V

COMPARISON BETWEEN STANDARD SCORE AND RAW SCORE GRADES AS THE CRITERION OF PREDICTION IN THE MULTIPLE REGRESSION ANALYSIS FOR THE SCHOOL B SAMPLE

	Grade Converted to Standard Scores				Correlation Between Standard Score and Raw Score Grades	Grade Used in Raw Score Form			
	Multiple R with all 9 aptitudes	Multiple R with last 3 significant aptitudes				Multiple R with all 9 Aptitudes	Multiple R with last 3 significant aptitudes		
	9	3	2	1		9	3	2	1
Level I	.77	.64 K	.58 Q	.48 S	r = .92	.76	.68 Q	.58 K	.49 S
Level II	.44	.27 N	.20 G	.17 S	r = .94	.33	.22 S	.13 G	.10 N
Level III	.48	.41 G	.39 K	.34 P	r = .94	.59	.53 S	.52 P	.44 K
Total	.30	.25 G	.23 N	.18 S	r = .86	.42	.37 Q	.34 S	.29 N

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